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DAMAGE NATURE OF FAMILY SHELTERS DUE TO CYCLONE SIDR: A STUDY OF SARANKHOLA UPAZILA

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Abstract

On 15 November 2007, super cyclone Sidr hit in Bangladesh with 240 kilometres (category- 4) wind speed per hour and storm surges up to 5 meters in some areas caused 3,406 deaths and affected 2.3 million households of one million were severely affected. Total damaged value was BDT 79,904 million over the country including housing sector (family shelter) BDT 57,915 million. Housing sector of Sarankhola Upazila has identified as worst affected coastal strip of coastal Bangladesh. Total affected households were 21,023 (out of 21900) including 13,267 severely and 6,756 moderately affected. The main objectives of the study are to find out the damage nature of family shelters due to cyclone Sidr; and to explore the causes behind of house damage. Data and information are collected from mainly primary sources. Among the affected families, 167 households (106 severely and 61 moderately affected) were surveyed which were selected using standard statistical software. Total 500 houses were found among the surveyed families which were either fully (66 percent) or partially (34 percent) damaged. Considering value of family shelters, 87.14 percent was damaged due to cyclone Sidr. This study also reveals that cyclonic wind pressure and associated storm surge were the main causes of house damage.

Key words: *Cyclone Sidr, House Damage, Cyclonic Wind, Storm Surge, Family Shelter*

1. Introduction

Bangladesh is one of most cyclone prone area of the world because of its location, climatic characteristics, multiplicity of rivers and the funnel-shape of coast. Cyclones hit the coastal regions of Bangladesh almost every year, severe cyclones occur mostly during pre (April-May) and post (September-December) monsoon periods and one of them cause the most destruction (Choudhury, 2001). Every year 1.18 cyclone hit in the coast of Bangladesh during last half century (1950-2000) (Islam, 2006). Of the 508 cyclones that have originated in the Bay of Bengal in the last 100 years, 17 percent have hit Bangladesh. Since 1995, five severe cyclones hit on the coast of Bangladesh (May 1997, September 1997, May 1998, November 2007 and May 2009). On average, a severe cyclone strikes Bangladesh every three years (Dasgupata *et al.* 2010; GoB, 2008).

Cyclone Sidr, one of the ten strongest cyclones for past 131 years struck the south-west coastal region in Bangladesh and caused the widespread serious damage (Hasegawa, 2008). It ravaged the coastal belt of Bangladesh with winds up to 240 kilometres per hour

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on 15th November, 2007. The category- 4 storm[2] was accompanied by tidal waves up to five meters high and surges up to 6 meters in some areas, breaching coastal and river embankments, flooding low-lying areas and causing extensive physical destruction. About 3,406 deaths have been blamed and damage and loss due to Cyclone Sidr was concentrated on the southwest coast of Bangladesh. On the basis of damage and loss in Bangladesh four districts such as Bagerhat, Barguna, Patuakhali and Pirojpur were identified as severely affected and a further eight (Khulna, Madaripur, Shariatpur, Barisal, Bhola, Satkhira, Jhalakathi, and Gopalganj) were identified as moderately affected. Of the 2.3 million households affected to some degree by the effects of Cyclone Sidr, about one million were seriously affected (MoFDM, 2008; GoB, 2008; Hakim, 2009).

Total damaged value of the country was BDT 79,904 million, in infrastructure sector it was BDT 71,064 million and that was the most affected sector. In housing total damaged value was BDT 57,915 million which is the sub-sector of the infrastructure sector obtain 81.496% of the infrastructure damaged value and 72.48% of the total damaged value of the country (GoB, 2008).

The human settlements in the coastal areas are mostly developed in an unorganized and isolated manner, primarily due to population pressure. In such a situation, community efforts to cope with disasters become extremely difficult. There are certain environmental conditions, which lead to development of cyclones making the coastal human settlements vulnerable to destruction. Lack of appropriate dissemination of location and hazard specific housing technique is another constraint towards disaster resistant housing in rural areas (Miyan, 2005; Ahmed, 2008).

Islam (2006) mentioned wind and storm surge are crucial factors in the determination of how much damage occurs in the coastal areas in association with any tropical cyclone. It is also important to delineate the regions based on cyclone risk and vulnerability for planning considerations.

Hossain *et al.* (2008) explored the damaged scenario of the rural and agricultural engineering infrastructures caused by cyclone Sidr and their impacts on the agriculture and livelihood sector in Bangladesh. Impacts also trigger the rural roads, embankments, water sanitation, shelters and food security in deed.

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[2] On the Saffir-Simpson Hurricane Scale, ranging from category 1 to 5. Wind speed 74-95mph represent category 1; 96-110 mph represent category 2; 111-129 mph represent category 3; 130-156 mph represent category 4 and ≥157 mph represent category5. (source: *en.wikipedia.org/wiki/Saffir–Simpson_Hurricane_Scale*)

According to Klemas (2009), 'Storm-induced flooding and other damage present a major problem as the coastal population continues to increase rapidly and sea level keeps rising.

Mallick *et al.* (2009) emphasized the structural strengthening of houses and infrastructure in coastal areas of Bangladesh. Hakim (2009) focused on post-disaster settlement, external assistance, shelter process, sustainability etc, in his study. On the other hand, Ahmed (2008) emphasized the impacts of cyclone Sidr on housing sector.

Considering the disaster impact on family shelters due to super cyclone Sidr, the following objectives are adopted for this study. Addressing the housing sector damage, the aim of the study is to analyze the damage nature of family shelters due to cyclone Sidr in Sarankhola Upazila, Bagerhat. Specific objectives are as follows-

To find out the damage nature of family shelters; and
To explore the causes behind of house damaged during cyclone Sidr.

2. Materials and Methods

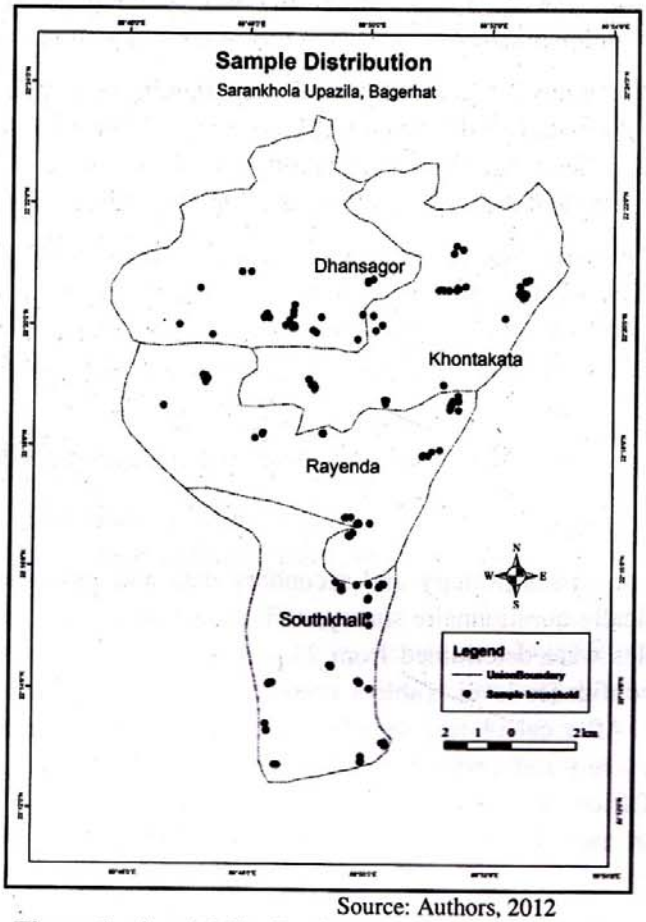
The research encompasses primary and secondary data and information. Primary data sources were basically questionnaire survey, official documents and informal interviews. About 167 samples were determined from 21,023 households using Raosoft[3] with 7% errors and 93% confidence level. Table 1 presents the population and respective sample size of the study. After calculating sample size, sample households have been selected from the list of severely and moderately affected households supplied by the PIO (Project Implementation Office) of upazila administration. GPS (Global Positioning System) has used taking spatial data of those households. Figure 1 depicts the spatial locations of the surveyed households. Survey was conducted during 14-21 February, 2012.

Table 1: Sample size of the affected households of the study area

Union No	Union Name	Total* damaged households	Total Sample	Fully* damaged households	Fully damaged households sample	Partially* damaged households	Partially damaged household sample
1	Dhansagor	3,767	29	1,348	15	1,819	14
2	Khontakata	5,889	48	3,081	26	2,808	22
3	Raenda	5,766	46	3,654	29	2,112	17
4	Southkhali	6,501	44	4,584	36	1,017	8
Total in Sarankhola		21,023	167	13,267	106	7,756	61

* Source: UNO office, 2012

[3] http://www.raosoft.com/samplesize.html



Source: Authors, 2012

Figure 1: Spatial distribution of sampled households

Before questionnaire survey, eight pilot questionnaires were tested at four unions (two in each union) in Sarankhola Upazila to find out whether the questions in the structured questionnaires were realistic, acceptable among affected household. After completing pre-test, essential corrections have been done and final questionnaire was prepared. It was a three pages questionnaire containing all relevant asking. Official information, raw data, documents were collected from the relevant offices of the upazila administration. During survey, several informal interviews were conducted among the affected people of the community understanding the ideas and facts of the research themes.

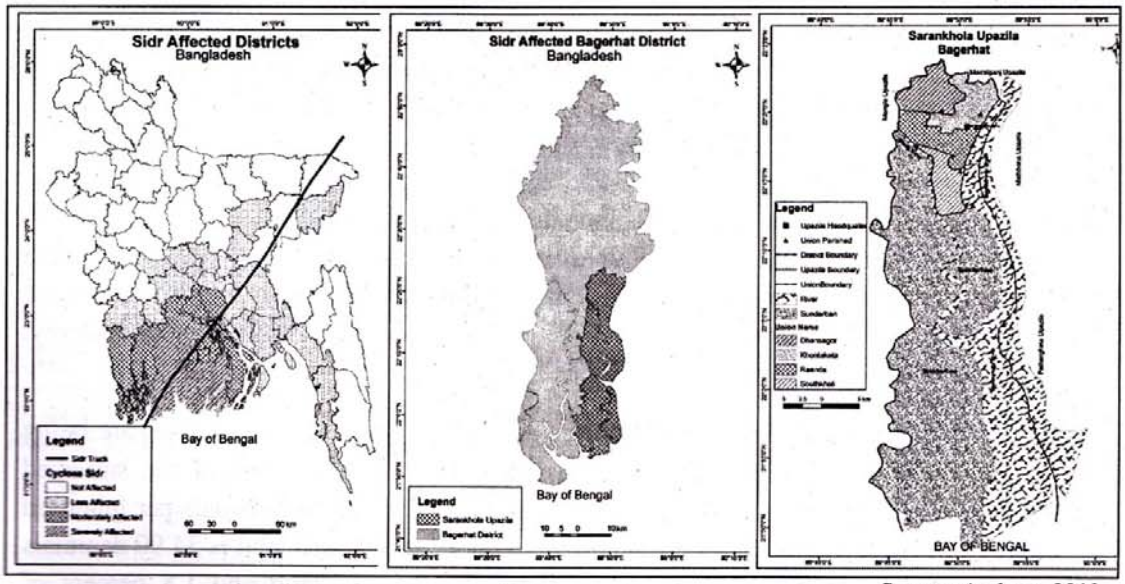
Secondary data were collected published documents relating cyclone Sidr from governmental offices like Disaster Management Bureau (DMB), Comprehensive Disaster Management Programme (CDMP), Local Governmental Engineering Department (LGED), several NGOs, INGOs (International Non-Governmental Organizations) such as

Muslim Aid, Rupantor, Red Crescent Society, Red Cross, Caritas, BRAC etc. Secondary data also collected from several books, journals, theses, reports and internet sources.

Data have been edited two times during field work and at data processing lab. Before data entry answers of questions have been coded as numeric or string. Some questions were pre-coded and some were post coded. After completed coding, data entry and analyses have done using SPSS Statistics 17.0 software. Upazila base map has collected from LGED. After digitizing administrative boundary of the study area, relevant (BTM) projection has incorporated. Google image (Google Earth 10) has overplayed with upazila boundary updating the physical and human features of the study area. After that GPS data have been transferred from GPS to GIS platform (ArcGIS 9.3 software) creating relevant maps whose are being presented the spatial analysis of the data.

Study Area

The upazila is located between $22^0 13'$ and $22^0 24'$ north latitudes and between $89^0 46'$ and $89^0 54'$ east longitudes. The upazila is bounded on the north by Morrelganj upazila, on the east by Mathbaria upazila of Pirozpur district and Patharghata upazila of Barguna district, on the south by the Bay of Bengal and on the west by Mongla upazila. The upazila occupies a total area of 756.61 sq.km including 594.58 km^2 forest areas (Sarankhola Forest Range). Total land 162.03 km^2 having 4 unions, 11 mauzas and 45 villages with 118,135 population having male 62,353 (52.78%) and female 55,782 (47.22%) (BBS, 2006).



Source: Authors, 2012

Figure 2: Location of study area and land area of Sarankhola upazila

3. Results and Discussion

3.1 Background of Households

Demographic and Economic: Total numbers of surveyed households were 167 (n-167) which consists of 770 members including 399 (52%) male and 371 (48%) female. Almost 83 percent single, 15 percent joint and only 2 percent extended family of surveyed households. Average household size is 4.61 while only 26.4 percent households have 2-3 family members and 3 percent households have 9-16 family members. About 30 percent (234) family members are economically active and rest of are dependent. Dependent population are under aged (below 20) and aged members (60 and above) of the families. Among the income people 37.61 percent are day labourer, 20.51 percent involve in business, 8.55 percent in agriculture, 15.81 percent service holder, 11.56 percent fishermen and 5.56 percent involve in other non-farm economic activities. Average monthly income among households is 6,308 BDT while maximum 1, 30,000 BDT and minimum 1,000 BDT. But 37.1 percent households' monthly income is between 3,000-6,000 BDT while 35.9 percent income less than 3,000 BDT. Moreover only 3.6 percent households' income is 15,000 plus BDT per month (Questionnaire survey, 2012).

Settlement: Among surveyed households, 50.9 percent are permanent (settlement duration above 90 years) and 49.1 percent are shifted from various places. They had to leave previous settlement locations because of riverbank erosion (5.4%); property sale (6%); unsuitable location (29.9%); disaster prone and insecure area (2.4%); and miscellaneous (5.4%) reasons. On the other hand, they have come at present settlement because of purchases land (36.5%), relatives land (6.6%), recovery requirement (1.2%), safety (2.4%), and government *khas* land (2.4%). Locations of surveyed households of the study area before Sidr (2007) and at present (February, 2012) were assed considering the embankment position, the only capacity to hydro-metrological hazards. About 91 percent households remain inside of the embankment, only a few of households' locations are in outside of the embankment (1.2%). Almost 7.8 percent households' locations have been changed due to Sidr over the years. Among them only 3.6 percent households' locations have changed from outside to inside embankment and 4.2 percent have also been changed from inside to outside of the embankment (Questionnaire survey, 2012).

Land Ownership: Land ownership and land area of the surveyed households are being present in Table 2. On an average, the current (2012) inherited land of the surveyed households is 52.1 percent and mean of the inherited land is 23.94 decimals per inherited household, purchased land 35.3 percent and mean of the purchased land is 34.90 decimals per purchased household, only a few of 2.4 percent is *khas* land and 1.8 percent of *barga*/leased land (Table 2).

Table 2: Land ownership and land area of the surveyed households

Ownership	Ownership nature		Land area in decimal	
	Frequency	Percent	Mean	St. deviation
Inherited	87	52.1	23.94	25.00
Purchased land	59	35.3	34.90	77.66
Khas land	4	2.4	5.30	5.28
Barga or leased land	3	1.8	7.70	1.90
Inherited and purchased	2	1.2	1.00	0.00
Miscellaneous nature	12	7.2	69.33	48.43
Total	**167**	**100.0**	**30.06**	**52.55**

Source: Field Survey, 2012

3.2 Damage Nature of Family Shelters

Among surveyed households (n-167), total numbers of damaged houses caused by Cyclone Sidr were 500 including 329 (65.8 percent) were fully damaged and 171 (34.2 percent) were partially damaged. Total estimated value of houses of surveyed households before Sidr was 187,52,000 BDT (per household 112,287 BDT) and total damaged value of surveyed houses was 163,43,000 BDT (per household 97,862 BDT) while fully damaged houses value was 9,676,000 BDT (per household 91,283 BDT) and of partially damaged houses value was 6,667,000 BDT (per household 109,295 BDT).

Table 3: Types, number and value of houses before Sidr (2007)

Type of houses	House 1	Value of house 1 (BDT)	House 2	Value of house 2 (BDT)	Number of total houses	Total value of houses (BDT)
Main room	106	55,34,000	61	62,57,000	167	117,91,000
Kitchen	106	15,56,000	61	10,69,000	167	26,25,000
Cow castle	79	8,75,000	17	2,00,000	96	10,75,000
Additional room	7	2,45,000	3	2,01,000	10	4,46,000
Other family members room	31	14,66,000	29	13,49,000	60	28,15,000
Total	**329**	**96,76,000**	**171**	**90,76,000**	**500**	**187,52,000**

House 1: Those houses fully damaged during cyclone Sidr
House 2: Those houses partially damaged during cyclone Sidr

Source: Field Survey, 2012

Table 3 presents the detail information relating types, numbers and value of houses before Sidr and on the other hand, Table 4 depicts the damaged types, numbers and value of fully and partially affected houses due to cyclone Sidr and its associated storm surge on 15 November, 2007.

Table 4: Types, number and value of damaged houses due to Sidr

Type of damaged houses	Fully damaged houses	Value (BDT)	Partially damaged houses	Value (BDT)	Number of total damaged houses	Total value (BDT)
Main room	106	55,34,000	61	45,81,000	167	101,15,000
Kitchen	106	15,56,000	61	8,51,000	167	24,07,000
Cow castle	79	8,75,000	17	1,74,000	96	10,49,000
Additional room	7	2,45,000	3	1,44,000	10	3,89,000
Other family members room	31	14,66,000	29	9,17,000	60	23,83,000
Total	**329**	**96,76,000**	**171**	**66,67,000**	**500**	**163,43,000**

Source: Field Survey, 2012

Design and pattern of damaged main houses: Design aspects of the surveyed main houses were presented in Table 5. Most of were (47.30 percent) four shaded (*Chaou Chala*) with balcony and only 0.6 percent house was *golpata* house; 26.95 percent were four shaded; 13.77 percent were two shaded and 11.38 percent houses were four shaded with *taak* (special traditional house type) (Table 5). Considering house pattern, most of the main houses (56.89 percent) were *katcha (*CI sheet and timber post), *golpata* and bamboo mat 18.56 percent, bamboo mat and CI sheet 13.77 percent, mud house 4.79 percent, semi pucca (brick-CI sheet-timber frame) 4.19 percent, timber frame and CI sheet (base pucca) 1.2 percent and only 0.6 percent were made by steel-truss, CI sheet and timber frame (Table 6).

Table 5: Design of damaged main houses

Types	Households	Percent
Two shaded *(Thou Chala)*	23	13.77
Four shaded *(Chala)*	45	26.95
Four shaded with balcony	79	47.30
Four shaded with *taak*	19	11.38
Golpata house	1	0.60
Total	**167**	**100.00**

Source: Field Survey, 2012

Table 6: Pattern of damaged main houses

House pattern	Frequency	Percent
Semi pucca (brick - CI sheet)	7	4.19
Timber frame and CI sheet (base pucca)	2	1.20
Katcha (CI sheet and timber post)	95	56.89
Katcha (bamboo mat and CI sheet)	23	13.77
Katcha (*goalpata* and bamboo mat)	31	18.56
CI sheet-steel truss- timber frame	1	0.60
Mud house	8	4.79
Total	**167**	**100**

Source: Field Survey, 2012

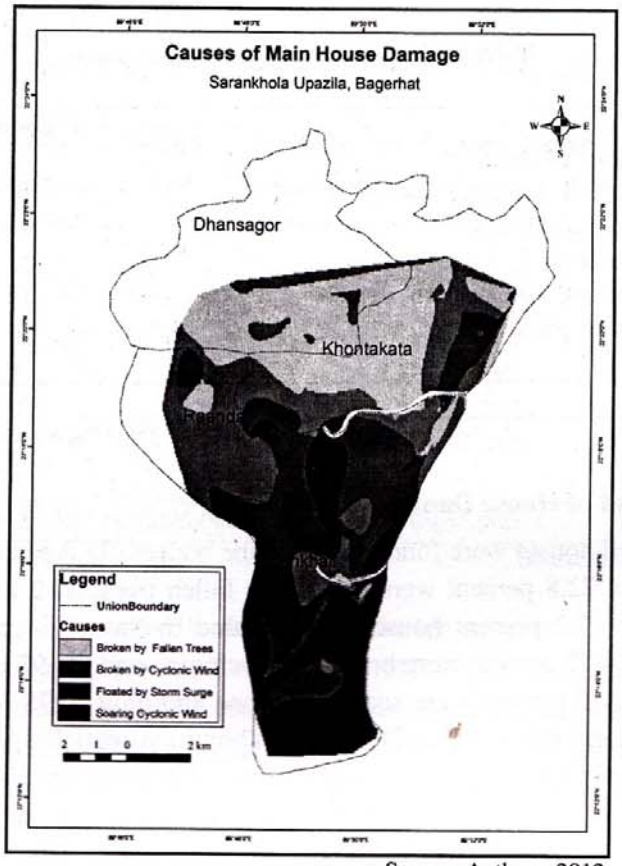
3.3 Causes Behind of House Damage

Total 500 damaged houses were found. Most of the houses (37.8 percent) were broken by cyclonic wind and 22.8 percent were broken by fallen trees, 22.2 percent were soaring cyclone and only 17.2 percent houses were floated by storm surge. Among the main houses (n-167) 40.72 percent were broken by cyclonic wind, 23.95 percent were broken by fallen trees, 24.55 percent were soaring cyclone and only 10.78 percent main houses were floated by storm surge (Table 7). Figure 4 shows the spatial aspect of causes behind the damage of family shelters. It is evident that the adjacent to the Baleshware River, the main damage factors were related wind speed and storm surge pressure.

Table 7: Causes of house damage

Causes	Total houses		Main house	
	Frequency	Percent	Frequency	Percent
Floated by storm surge	86	17.2	18	10.78
Soaring cyclonic wind	111	22.2	41	24.55
Broken by fallen trees	114	22.8	40	23.95
Broken by cyclonic wind	189	37.8	68	40.72
Total	**500**	**100**	**167**	**100**

Source: Field survey, 2012



Source: Authors, 2012

Figure 3: Spatial distribution of causes of main house damage due to cyclone Sidr

4. Conclusion

Every year, Bangladesh faces an average of 1.8 tropical storms or cyclones. Due to Cyclone Sidr, the housing sector of the study area was seriously affected as these family shelters were not designed with cyclone resistant. Traditional houses materials were used to make these family shelters. The study found that total affected households were 21,023 where 13,267 were fully damaged and 7,756 were partially damaged. Among the surveyed households (n-167) total damaged houses were 500, where 60 percent houses either broken or soaring due to cyclonic wind and storm surge. So, sustainable house designs along with materials need to be used to reconstruct family shelters among the affected households which will increase their adaptive capacity to face the upcoming disaster events near future.

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